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JOURNAL
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VOLUME XXX AUGUST, 1914 No. 2

PROCEEDINGS OF THE THIRTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE

Held at Trinity College, Durham, N. C., Friday and Saturday, May 1 and 2, 1914

The Executive Committee, President Sherman and Secretary Gudger, *ex officio,* and Messrs. C. S. Brimley, W. C. Coker, and J. J. Wolfe present, met at 2:30 P. M. Friday, May 1. The secretary made his annual report of the finances and membership of the Academy and this was recommended favorably to the Academy at its annual business meeting. The following were elected to membership:

(1) Wm. Battle Cobb, Soil Scientist, U. S. Department of Agriculture, Washington, D. C.

(2) C. M. Farmer, Professor of Natural Science, Atlantic Christian College, Wilson.

(3) E. Oscar Randolph, Assistant in Geology, University of North Carolina, Chapel Hill.

(4) Henry Roland Totten, Assistant in Botany, University of North Carolina, Chapel Hill.

The invitation of the President and Faculty of Wake Forest College that the Academy hold its fourteenth annual meeting as the guest of that institution was unanimously accepted.

An amendment to the constitution adding the vice-president to the list of *ex officio* members of the Executive Committee was offered by C. S. Brimley, discussed by the Committee, and recommended to the favorable consideration of the Academy. The Committee then adjourned.

At 3 P. M. President Sherman called the Academy to order and appointed the following committees: Nominating, H. V. Wilson, W. C. Coker, W. H. Pegram; Auditing, C. W. Edwards, J. D. Ives, and R. W. Collett; Resolutions, C. S. Brimley, Z. P. Metcalf, and W. N. Hutt.

The reading and discussion of papers was then begun and continued until adjournment was had at 6 P. M., when 11 numbers had been disposed of. In attendance were 23 members and a number of visitors.

The academy reconvened at 8 P. M. in the Y. M. C. A. Hall, when, after a hearty welcome to Trinity College from Dean W. I. Cranford, President Franklin Sherman, Jr., of the Academy, gave his presidential address on the subject " Studies of the Animal Life of our State with Suggestions for a Biological Survey (illustrated by numerous charts).

Next, Professor A. H. Patterson delivered a lecture "The Gyroscope and Its Modern Applications," illustrated with some fine apparatus. Then Mr. Bert Cunningham gave a striking demonstration of the new Nitrogen Tungsten lamp, showing it in comparison with the ordinary Tungsten and Carbon lamps consuming the same amount of current.

Following this the faculty of Trinity College entertained the Academy at a much enjoyed smoker.

At 9 A. M. Saturday the Academy met in annual business meeting, with the President in the chair, and some 20 members present. The proceedings of last meeting were read and approved, and the report of the Secretary and Executive Committee were called for. Mr. Brimley's amendment to the constitution, Art. III, Sec. 1, was adopted. This now reads: " . . . and an Executive Committee of *six,* including the President, *Vice-President,* Secretary," the italicized words indicating the change and the addition.

The Auditing Committee reported the books and accounts, and the financial statement of the Secretary-Treasurer to be correct. The Secretary-Treasurer then read his itemized financial statement which is included herewith and showed that the current dues are insufficient to carry the current expenses of the

Academy and that it is now necessary to draw every year on the savings bank account. There was some discussion with regard to an amendment to the Constitution increasing the dues but it was finally decided to let the matter go over until next year.

Chairman Brimley of the Resolutions Committee, reported the following resolutions which were unanimously adopted:

Resolved; (1). That we express our sincere appreciation of the many courtesies and generous hospitality extended to us by the Faculty of Trinity College; (2). That we commend our efficient Secretary for his zeal and assiduity in the performance of his duties; (3). That we express our approval of the recommendations of our President for a Biological Survey of the State and suggest that all our members co-operate in gathering data to further that end.

The Nominating Committee submitted its report and officers were unanimously elected as follows:

President, J. J. Wolfe, Professor of Biology, Trinity College, Durham.

Vice-President, A. H. Patterson, Professor of Physics, University of North Carolina, Chapel Hill.

Secretary-Treasurer, E. W. Gudger, Professor of Biology, State Normal College, Greensboro.

Executive Committee: W. N. Hutt, Horticulturist, State Department of Agriculture, Raleigh; J. H. Pratt, State Geologist, Chapel Hill; W. A. Withers, Chief Chemist, North Carolina Agricultural Experiment Station, West Raleigh.

Chairman Edwards, of the committee appointed in 1912 and continued last year, brought forward the following report on ventilation of public buildings: "Resolved, that the North Carolina Academy of Science recommends that legislation be enacted specifying the minimum standard of ventilation in schools, public auditoriums, and penal institutions in North Carolina and that this committee be authorized to submit to the proper legislative committee all data accumulated by it concerning this matter." This was so ordered.

The question of changing the time of the annual meeting was raised and discussed. Some of the members thought it better to have it earlier in the spring, increasing the time between the meetings and the commencements of the colleges; others advo-

cated having it in the fall about Thanksgiving. Finally, however, the matter was left in abeyance until the next meeting.

The Secretary reported that on January 1st, 1913, there were 81 members; that during the year 15 were lost by withdrawals, removals from the state, and non-payment of dues; and that 12 new members were elected; the number at the beginning of the year 1914 being 78.

At 9:45 the reading of papers was resumed and continued until all were finished and adjournment was had at 12:30. There were 30 papers on the program, of which only two were read by title, the others being given by their authors.

The membership of the Academy at the present time is as follows—those present at the meeting being indicated by a *:

Allen, W. M.; Balcomb, E. E.; Booker, Warren H.; Boomhour, J. G.; *Brimley, C. S.; Brimley, H. H.; Bruner, S. C.; Cain, William; Clapp, S. C.; *Cobb, Collier; Cobb, Wm. B.; Coker, R. E.; *Coker, W. C.; *Collett, R. W.; *Cunningham, Bert; Dixon, A. A.; Downing, J. S.; *Edwards, C. W.; *Farmer, C. M.; *Fulton, H. R.; *George, W. C.; Gove, Anna M.; *Gudger, E. W.; Hammel, W. C. A.; Harding, W. T.; Herty, C. H.; Hobbs, A. Wilson; Hoffmann, S. W.; Holmes, J. S.; Holmes, J. A.; *Hutt, W. N.; *Ives, J. D.; Kilgore, B. W.; Lanneau, J. F.; *Lay, George W.; Lewis, R. H.; McIver, Mrs. Chas. D.; MacNider, W. de B.; *Markham, C. B.; Mendenhall, Gertrude W.; *Metcalf, C. L.; *Metcalf, Z. P.; Mills, J. E.; Newman, C. L.; *Norton, W. C.; *Patterson, A. H.; *Pegram, W. H.; Poteat, W. L.; *Pratt, J. H.; Radcliffe, Lewis; Ragsdale, Virginia; *Randolph, E. Oscar; Rankin, W. S.; Robinson, Mary; *Sherman, Franklin, Jr.; Shore, C. A.; *Smith, J. E.; Stiles, C. W.; Strong, Cora; *Totten, Henry R.; Venable, F. P.; Wheeler, A. S.; Williams, L. F.; *Wilson, H. V.; *Wilson, R. N.; Winters, R. Y.; Withers, W. A.; *Wolfe, J. J.

In addition to the presidential address, which is published in full in this number, the following papers were presented:

ECONOMIC GEOLOGY OF CHAPEL HILL, N. C. AND VICINITY.

JOHN E. SMITH

GENERALIZED SECTION OF MANTLE ROCK.

1. Soil, "Top Soil," red to gray or black..... 1 to 3 feet
2. Subsoil, fine, somewhat compact, red to yellow clay..... 3 to 10 feet
3. Clay, coarse and lumpy, with some sand..... 5 to 20 feet
4. "Natural Sand-Clay," feldspar, quartz, sand and clay....10 to 20 feet
5. Fragmental Rock, angular, decayed, size 2 to 4 inches....10 to 20 feet
6. Fragmental Rock, coarser and fresher than that in 5.... 5 to 15 feet
7. Granite, "Bed Rock," "Country Rock."

This region serves as a type for Piedmont areas in which granite is the underlying rock—about one-third of the Piedmont Belt.

Zone No. 1 is the surface soil of the upland and is used in agriculture and in road building. No. 2 provides clay suitable for brick and tile. As the topography is mature and these zones have been removed by erosion from much of the area, the value of the land is low. The material of zone 4 makes good sand-clay roads. This is approximately horizontal and outcrops on the slopes where valleys have been cut below its depth. Stream sand is used in making mortar and in road construction.

This mantle rock forms an excellent filter and most wells in it are free from contamination. Excepting the mountain region, these are the most healthful areas in the South.

AN ACHLYA OF HYBRID (?) ORIGIN

W. C. COKER.

An Achlya was described from Chapel Hill, N. C. with pecularities that suggest a hybrid origin. The tips of the hyphae often die and the growth is then extended as a side branch below the dead tip. The spores show a strong tendency to poor organization, the protoplasm often segregating only imperfectly, and producing irregular masses of various sizes. The same is true of the eggs, which are of any size and almost never become perfectly organized, and die quickly. The plant seems most like *Achlya polyandra* Hildeband, but differs from it in the walls of the oogonia being pitted and in the abnormal behavior of the eggs.

It is suggested that the plant may be a hybrid between A. *DeBaryana* Humphrey and A. *apiculata* DeBary.

THE NURSE SHARKS OF BOCA GRANDE CAY, FLORIDA.

E. W. GUDGER.

Boca Grande Cay is an island of coral sand and mangroves lying about 20 miles west of Key West. Situated on a shallow submarine platform, about 120° of its circumference is surrounded by sand flats inhabited

largely by sting rays. Another 140° of its circumference is bounded by a shallow gently sloping rock bottom on which the water a half mile from shore will not be over a man's shoulders. On this rocky bottom, the nurse sharks, *Ginglymostoma cirratum*, come out to bask in the sun, to play, to breed, and possibly to feed. Here they are found in large numbers. A dozen can be seen at almost any time, and 33 have been counted in the sweep of the eye.

These sharks in looks and habits much remind one of well fed pigs in a barnyard. They are much broader in the pectoral region than ordinary sharks, are sluggish in their movements, and are comparatively unafraid of man. They frequently lie in water so shallow that their dorsals project above the surface, and a number of times they allowed the boat to drift down over them and strike their fins before they would move.

They lie with heads on each others pectorals or tails, or one will have his snout elevated on another's flank, or they will lie heads and tails together or in a confused herd. Here again this similarity in habits to barnyard pigs is very noticeable. Further they often swim one after another to the number of three or four in an aimless fashion, each one following the purposeless turnings of its leader.

They are perfectly harmless. Their mouths are small and filled with small pointed teeth. They are omniverous in feeding, like most sharks, but their food seems chiefly to be crustacean, probably consisting of the large spiny "crawfish" common on the reef and on rocky bottom of any kind.

Under the circumstances noted above, there is, of course, no difficulty in killing these sharks. Ordinarily shark fishing is good sport, but killing nurse sharks is no more exciting than sticking pigs in a barnyard. Indeed the Key West fishermen contemptuously speak of them as "Nurses", and of the other sharks as "sharks".

Work on the habits and embryology of this shark is being carried on under the auspices of the Marine Laboratory of the Carnegie Institution of Washington situated at Tortugas and will be continued this summer.

FLOWERS AND SEED DEVELOPMENT OF SPECULARIA PERFOLIATA.

H. R. TOTTEN AND J. A. MCKAY.

There are two kinds of flowers, conspicuous open ones with normal corollas and small bud-like flowers that never open. The last or cleistogamic flowers were described carefully by von Mohl, as long ago as 1863.

It is the object of this paper to give the development of the seeds in the cleistogamic flowers. The seeds are of the same size and appearance as those borne in the open flowers. Four megaspores are formed and

the embryo-sac develops from the lower one. It is surrounded by a single nucellar layer and one thick integument. The endosperm nucleus forms a cellular endosperm from the first division. The young endosperm sends out a knob-like haustorium of one or two cells at each end. The suspensor of the embryo grows up into the micropylar haustorium, to some extent, forming a small enlarged knob there. As the seed grows the haustoria are encroached upon and destroyed.

STUDIES IN THE TOXICITY OF COTTONSEED MEAL

W. A. WITHERS, R. S. CURTIS AND G. A. ROBERTS

About one-hundred and seventy-five hogs were fed upon cottonseed meal or some fraction of it. The swine died in every case after eating the meal for periods ranging on average from 59 to 96 days. Twenty-two rabbits fed on cottonseed meal died on average of 13 days.

With different solvents used, the extract was usually nontoxic and the residue usually toxic.

Green feed, liberal exercise and ashes seemed to be of some aid to pigs in overcoming the toxic effect of Cottonseed meal. Treatment of the meal with an alcoholic alkali rendered the meal non-toxic to rabbits.

Citrate of iron and ammonia was effective with rabbits and ferrous sulphate was effective with swine as an antidote to the toxicity of cottonseed meal.

THE LOCUST TREE CARPENTER MOTH, A FORMIDABLE PARASITE OF THE OAK.

J. J. WOLFE.

In February, 1911, a white oak about fourteen inches in diameter, on the campus of Trinity College was seen to be severely injured as a result of the boring habits of what proved to be the larvae of *Pryonoxystus robiniae,* commonly known as the locust tree carpenter moth. The tree was cut and sections of the trunk split into two pieces. Numerous winding tunnels were found throughout the heart and sap wood of the trunk and larger limbs. From these were collected fourteen larvae of three distinct sizes—a fact supporting the view that the insect requires three years for its development. A portion of the trunk near the ground was riddled with holes—points of exit—in which wood destroying fungi had established themselves and threatened the destruction of the tree.

The insect attacks several trees of the street, park and forest. Its habits render it a formidable pest. Means for its control on any large scale are at present wanting, but sporadic occurrences in trees of streets and parks might possibly be held in check by injecting into these tunnels a volatile poison and then plugging them with some waxy substance.

THE PECAN TWIG GIRDLER.

C. L. METCALF.

A detailed account of the egg-laying habits of *Oncideres cingulata* Say. The preliminary and supplementary maneuvers habitually performed (which result in the severing of numerous twigs from the tree in which the eggs are laid); with a brief account of the life-history, economic importance and methods of control of the pest in commercial pecan orchards.

A ROUGH METHOD OF RECORDING SEASONAL DISTRIBUTION.

C. S. BRIMLEY.

The method I am about to describe is not meant to take the place of full records or complete data with regard to any group of living things in which one is particularly interested, but rather to provide a convenient means of summarising such records and also to record data concerning animals or plants in which one is less interested and therefore is not likely to take much trouble about.

The method is briefly this, rule the left-hand pages of a blank book into 12 vertical columns, leaving enough space on the left for the names of the species to be recorded, and leaving the right hand page blank for any additional data. At the head of these twelve columns write the abbreviations, Jan., Feb., Mar., Apl., May., Jun., Jly., Aug., Sep., Oct., Nov., Dec., and when you have a record to make of a species, record it by the appropriate letter of the month in the column for that month, J. standing for early January, a for middle January, n for late January and so on, "early" signifying from the first to tenth inclusive, middle for from eleventh to twentieth, late from twenty-first to end of month.

I have hundreds of species of insects recorded in this way and the records are both easy of access and very serviceable when one wishes to find at what period of the year any particular insect is likely to occur. Of course, separate records could be kept for each year and should, of course, be kept for different localities, but as a matter of course such a system would necessarily come into use mainly for the locality in which one spends the greater part of one's time.

SOME RARE PLANTS AND SINGULAR DISTRIBUTIONS IN NORTH CAROLINA.

W. C. COKER.

Announcement was made of the addition of a new tree to the flora of North Carolina. The Pin Oak (*Quercus palustris* DuRoi.) was found near Chapel Hill by Mr. J. S. Holmes, State Forester, in the fall of 1913. *Rhododendron catawbiense* Michx., supposed to be confined in this

state to the tops of the highest mountains, was reported as growing at Chapel Hill, Hillsboro, and other places in Orange county, and stranger still at Cary (near Raleigh), and even at Selma which is well within the coastal plain.

Venus' Fly Trap (*Dionaea muscipula* Ellis.). Evidence as to distribution of this remarkable plant was reviewed and it was concluded that that species is distributed from Buckville, S. C., to New Bern, N. C., and westward along the Cape Fear River to Fayetteville.

The tuberous variety of Tall Meadow Oat grass (*Arrhenatherum elatius* (L.) Beauv., var. *bulbosum*) was exhibited from Chapel Hill. This is a recent introduction from Europe where it is known as a troublesome weed. Within the last three years the U. S. Department of Agriculture has received it occasionally from Virginia to Georgia.

Blessed Thistle (*Cnicus benedictus* L.) was shown to be a troublesome weed in Chapel Hill grain fields.

Euonymus atropurpureus Jacq. This is found to be one of the rarest shrubs in North Carolina, and known with certainty only from Chapel Hill.

THE LAWN PROBLEM IN THE SOUTH.

W. C. COKER AND E. O. RANDOLPH.

This paper attempts to find some way of solving the hard problem of lawn making in the South. Observations were made on many lawns, with various conditions of soil, exposure and care, to determine the grasses and weeds actually present. About six of the most promising grasses were carefully studied to determine their value and use as lawn cover.

Exhibits were made in trays of good sods formed by these six grasses, and also of some of the worst lawn weeds.

No abstracts have been received for the following papers:

Movements of Plants—J. D. Ives.

A Report on Local Protozoa—Z. P. Metcalf.

By Raft and Portage—A Study in Early Transportation in North Carolina—Collier Cobb.

The Case of the Riparian Owner—R. N. Wilson.

Some Philippine Sponges—H. V. Wilson.

Economic Minerals in the Pegmatite Dikes of Western North Carolina—J. H. Pratt.

The Sclerotinia Disease of Clovers and Alfalfa—H. R. Fulton.

The Use of Home-made Models as an Aid in Teaching Embryology—W. C. George.

Electrical Conduction of Flowing Mercury—V. L. Chrisler, presented by A. H. Patterson.

Microscopic Demonstration of Protozoan Spores, Used as Proof of Contamination of Food with Human Excrement—C. W. Stiles.

Some Recent Developments in the Theory of X-Rays—C. W. Edwards.

The Gyroscope and its Modern Applications (with a demonstration)—A. H. Petterson.

The Coggins Gold Mine—J. H. Pratt.

Geology in Relation to the Location of Highways in North Carolina—Collier Cobb.

The Corn Bill Bug—Z. P. Metcalf.

A Peculiar Case of Freezing—R. N. Wilson.

The Nitrogen Tungsten Lamp—Bert Cunningham.

E. W. GUDGER.
Secretary

STUDIES OF THE ANIMAL LIFE OF NORTH CAROLINA WITH SUGGESTIONS FOR A BIOLOGICAL SURVEY*

FRANKLIN SHERMAN, JR.

When it became known to me that the North Carolina Academy of Science, at its last meeting (which I did not attend) had made the mistake of thrusting upon me the presidential honors for this session,—one of the first questions that arose in my mind was as to the topic, subject-matter and method of presentation of the annual address. I have had special misgivings upon this subject because of the fact that my immediate predecessor, Mr. C. S. Brimley, has tastes and views so similar to my own, that I feared that the thoughts which I might present would bear almost too close a resemblance to his. It is already known to some of you that Mr. Brimley and myself have been for some years accumulating records, data, and specimens bearing upon the occurrence and distribution of the native animals of the state. At our meeting in Greensboro in 1908 we presented a joint paper on the Life Zones of the state. Both of us have (both at these meetings and in technical journals) presented lists and data bearing on this topic, and Mr. Brimley's Presidential Address a year ago upon the subject of "Zoo-geography" laid further emphasis upon this subject.

In the hope that through the activities of the Academy, the individuals thereof, and the institutions represented in its membership, we may be able to place these and related studies on a better footing, and in the further hope that the topic may carry some measure of interest to our visitors on this occasion, I now venture to open the subject of this address.

When any person, scientist or layman, has his interest aroused by any new, strange or interesting plant or animal, among the first and most natural questions are these: What is its name? Does it normally live and thrive in this locality? Where else does it occur? At what seasons are its activities evi-

* Presidential Address before the North Carolina Academy of Science, Durham, N. C., May 1, 1914.

dent? Is it really rare? What are its economic relations, that is, is it beneficial, or harmful, or merely neutral? And if is neutral, or practically so, on which side of the balance would its weight be felt if it should in future increase to excessive numbers?

These are logical and reasonable questions, and such as the public might expect biologists to be able to answer. Yet at present this information in any detail at least, is lacking for the majority of our native animals. North Carolina is not poorer in this respect than most other states, but it wuold seem to be a reasonable ambition to assemble and publish such facts and data, as would give us some reliable source for reference on such matters.

A very little sincere study will show any student that the general public has little or no really definite knowledge to offer on these questions. For example, among our native animals no group is more appreciated than the birds, yet if we ask even an intelligent layman to name the birds which he positively knows at sight, we will find that his list is pitifully scant, and his knowledge of these few indefinite. Even our favorite Mocking-bird is often confused with the Logger-head Shrike, a bird whose habits are totally different and which resembles the Mocker only in superficial appearance. A single female of the Rusty Blackbird would certainly often pass as a "Catbird," the whole group of dull-colored but interesting and important Sparrows pass by such indefinite and misleading names as "bush sparrows" and "field birds," and the large family of Wood-warblers, which is the most gaily colored group of all and one of the most abundant in individuals and species,—is scarcely known at all except to bird students.

And if this is true in the field of Ornithology, which is one of the most popular of all the branches of Biology, how much more is it true of the other branches, especially those which deal with the so-called "lower" and more obscure groups of animals, and of plants? Even the most intelligent farmers have very little really definite knowledge of the weeds which annoy them, or of the insects which attack their crops.

We can never expect that the general public will become really well informed on the subjects, but it is certainly in line with our duty as specialists in the study of these problems that we should aim to make this definite and exact information available not only to ourselves but to our co-workers and to such other persons as may be sufficiently interested to study these subjects as amateurs.

As soon as a group of animals (or plants) is proven or suspected to be of economic importance it becomes a fit subject for study by our recognized institutions, and results of such study usually find a ready means of publication in the bulletins and reports of agricultural or educational institutions. But data upon subjects the economic application of which is or seems to be remote, cannot so easily find a place for publication, especially if they deal with strictly state or local matters. Yet every student knows how difficult it is to draw the line clearly between what is, and what is not, of economic bearing. Even an inconspicuous form of life with apparently no economic relations, may on occasion prove to be important, hence if our studies are really to be broad we must include forms which for the present appear to be of no account. Recent developments in the field of Medical Entomology will make this clear. Only a very few years ago the common House-fly was regarded merely as an insect which annoyed us at times, but which was popularly believed to "keep the air pure"; but now we know that its life is associated with filth and is fraught with almost endless possibilities in the spread of serious diseases of mankind. The Mosquitoes comprise another group of insects which we formerly regarded merely as annoying, but which we now know to be concerned in the spread of both malaria and yellow fever, and much of the sanitary work now being done in Cuba, Panama and other tropical and sub-tropical localities is aimed at mosquito control. A few years ago an exhaustive study of the mosquito fauna of a state (North Carolina for instance) would have aroused skepticism and ridicule so far as its economic aspects were concerned,—now it appears highly desirable. Several states have made more or less exhaustive studies of the subject, notably

New Jersey, and even in North Carolina, both the State Board of Health and the Public Health Service at Washington are making studies.

Fortunately for the present day scientist, the public is rapidly coming to realize that an exhaustive study of what at first seem to be even the most abstruse subjects may ultimately yield results of far-reaching import, especially if they have to do with natural laws or principles upon which all of our life and our activities are dependent. The microscopist studying forms invisible to the naked eye may appear to be interested in matters which are of literally small concern, but it was just such studies that laid the foundations for all of our present knowledge of bacteriology and verified the existence of bacteria themselves.

Broadly speaking, the students of American fauna are divided into two great schools: (1) Those who are interested primarily in the study of principles of life, death, reproduction and development,—experimental biology and morphology, and (2) Those who are interested primarily in knowing the numerous species themselves, their classification, distribution over the earth, and the seasons during which they may be found. It is more especially this latter phase of the subject to which I now invite your attention:

Parker and Haswell (1897) have divided our animal kingdom into 12 branches or phyla. All of what we popularly know as the "higher" animals, fishes, batrachians, reptiles, birds and mammals (including man) fall into one of these 12 phyla. Were I preparing this discussion for an audience of strictly technical zoologists, scientific accuracy would demand that I discuss them in proper scientific order, but as it is the function of this address to put ideas into shape so that they may be understood by persons not technically interested, I shall for the purposes of this discussion, divide our fauna (animal life) into seven groups as follows:

Invertebrates (no backbone)
1. Marine Invertebrates.
2. Fresh-water and Land Invertebrates—not insects.
3. Insects.

Vertebrates (with backbone)
4. Fishes.
5. Reptiles and Batrachians.
6. Birds.
7. Mammals.

Thus all the invertebrated animals, which are technically divided into eleven groups, are here put into three, and the vertebrated animals which technically comprise only one group, are here for easier understanding, divided into four.

In this division we must remember that there is much overlapping of forms, especially in the water-inhabiting invertebrates, for a single zoological group may contain some species living in fresh water, and others which are strictly marine.

What progress has been made in the study of what our state affords in these several groups? Remembering that several of these groups contain thousands of species, my hearers will excuse me if I fail to discuss all the groups in full detail.

I. MARINE INVERTEBRATES

This group includes thousands of small, little-known forms of life, along with a host of larger and better-known forms. Such work as has been done in listing and making known our species has been chiefly at the government Biological Laboratory at Beaufort where there are special facilities for work. Dr. H. V. Wilson, of the State University, informs me that the sub-groups of this group which are best known from the systematic standpoint are:

The Coelenterates (Jelly-fishes, Sea-anemones, Corals, etc.)
Echinoderms (Star-fishes, Sea-urchins, Brittle-stars, Feather-stars, Sea-cucumbers.)
Crustacea (Crabs, Lobsters, Shrimp, etc.)
Mollusca (Bivalved shells, Conchs, snails, etc.)

Dr. Wilson informs me that the larger forms of Crustacea will be thoroughly listed in a paper soon to be published by Dr. Hay, of Washington, and Dr. Shore, of Raleigh. This list includes parts of several of the most important zoological groups, but leaves the whole group of one-celled animals largely unex-

plored, except that the marine forms have been partially studied at Beaufort by Professor Edmundson of the University of Oregon. Comparatively few of the marine worms appear to have been recorded, much less has the geographical range of these on our coast been worked out.

Our three prominent capes, Fear, Lookout, and Hatteras, each presumably mark the northern or southern distribution of certain species of marine and coast-inhabiting animals. Perhaps no other one locality on our coast offers so good a field for systematic collecting as Beaufort, but the thorough student of the distribution of our coast forms would wish to explore both sides of each of these three capes.

Studies from the morphological side of the subject have been conducted among the Porifera (sponges), the leader in this being Dr. Wilson, of our State University, also in the Coelenterates, Echinoderms, and larger species of Crustacea.

II. LAND AND FRESH-WATER INVERTEBRATES,—NOT INSECTS

Such common forms as earth-worms, snails, crayfish, centipedes, millipedes, spiders, ticks and mites are here included. Entimologists incidentally accumulate some knowledge of millipedes, spiders and ticks on account of their obvious affinities to, or association with, insects,—but the true worms and snails have been very little studied, though every person in this audience has known them from childhood. Verily, it is often the commonest things of which we know the least. If I could advertise, and here place on exhibit even the smallest bit of entirely lifeless matter genuinely known to have come from the planet Mars, I doubt not that this hall would be crowded with persons eager to quench their thirst for knowledge by gazing at the specimen, yet many of those same persons would not know that some of the common snails in our gardens naturally have a shell, while other common snails naturally never have a shell.

Mr. C. S. Brimley has studied the spiders and millipedes of Raleigh to some extent, and Mr. Nathan Banks, of the National Museum at Washington, has collected spiders quite assiduously for several weeks in the vicinity of Black Mountain, but

here our knowledge of the state fauna in this group comes practically to a standstill, save for some earlier accounts and descriptions of our spiders published by Mr. Hentz, and by Prof. Atkinson.

III. INSECTS

We now come to a group which in numbers of species far out-ranks all others, indeed, it far out-ranks all others combined. Aproximately four-fifths of all known species of animals are insects. Furthermore in their economic aspects they are extremely important, not only as pests to crops, domestic animals and to man, but also as carriers of important diseases. A few have been domesticated to form distinct commercial assets, such as the silk-worm and the honey-bee, while others are useful as natural enemies of the destructive sorts.

It is but natural that so important a group as this should attract students, and not only are there amateur entomologists (though very few in North Carolina), but both Federal and State governments have seen fit to employ persons in the study of this group,—mostly on the purely economic questions involved,—but to some extent on the systematic and morphological sides as well. And it is essential that a student in entomology should have some knowledge of insect classification, else he will surely become entangled, confused and seriously misled among the innumerable closely related species. It has been an ambition of the speaker to contribute in some degree toward making known the insect fauna of the state, and in this effort he had help not only from those officially associated with him, but from Mr. C. S. Brimley, of Raleigh, Rev. A. H. Manee, of Southern Pines, and from specialists in other states who have identified many specimens and who in some instances have taken an actual part in exploring our rich and varied insect fauna.

For our purposes we may consider our Insects as falling into seven principal groups, though there are several other smaller groups, some of which fall readily into one or another of the seven, and some of which do not.

The seven main groups are:

1. Roaches, Crickets, Katydids, Grasshoppers, etc., *Orthoptera.*
2. Cicadas, Scales, Plant-lice, Squash-bug, Electric-light bug, and relatives, *Hemiptera.*
3. Dragon-flies, May-flies, Stone-flies, etc., *Neuroptera.*
4. Moths and Butterflies, *Lepidoptera.*
5. House-fly, Mosquitoes, Gnats, and relatives, *Diptera.*
6. Beetles, hard-shelled, with wing-covers meeting straight down back, *Coleoptera.*
7. Ants, Bees and Wasps, *Hymenoptera.*

(1) The first group is decidedly the smallest in number of species and is one of the easiest to collect and study owing to the average large size of the insects, and the ease with which many of them can be collected. The group is of some active, and great potential, economic importance. Owing to the fact that few if any of our species ever indulge in long sustained flight or migrations, they are good subjects for the study of distribution. For all these reasons the group has received some special attention.

The recorded state fauna in this group, includes approximately 160 species. Analyzing our card-catalogue data, we find that these records are drawn from exactly 102 post office localities, counting distinct mountain peaks as localities. But that many of these are merely isolated, scattering records is shown by the fact that only eighteen localities are credited with 15 or more species, only nine show more than 25, while only two show more than 50 species. Raleigh, with 115 species is the only locality whose species are at all fully recorded. Asheville comes next with about half of its probable forms listed. Southern Pines, Waynesville, Blowing Rock and Wilmington have enough records to give a fair idea of their characteristic forms, but in all of these, save possibly Raleigh, a large share of the smaller and rarer forms still awaits discovery by the careful student of distribution. So while the list of species for the state as a whole is fairly complete we are much lacking in data as to the exact range of the species within the state as well as the exact seasons during which they may be found. And to my mind the listing of our fauna, to be at all complete, should not only include the species occurring but also show their geographical and seasonal distribution. A list of species if at all com-

plete is enlightening, but it becomes vastly more useful if it also shows where and when the species are to be found.

Let us see to what extent the geographical range of this group as a whole has been determined for our state. On this point we can indicate the recorded distribution of 155 species.

Records indicating distribution over whole state	28 species.
Records indicating distribution on coast only	1 species
Records indicating distribution in eastern half	22 species.
Records indicating distribution in central portion	11 species.
Records indicating distribution western half	16 species.
Records indicating distribution mountains only	20 species.
Recorded from few scattered localities	19 species.
Recorded from only one locality	38 species.

Remembering that we are now discussing a group of insects which has immense latent powers for evil, it can readily be seen that this kind of data, the more complete the better, can be drawn upon in defining the area where damage is likely to be serious when any species threatens. If a grasshopper suddenly becomes a pest in any locality we have a valuable clue to the possible ultimate meaning of the outbreak if we know the distribution of the species. If thorough records were available for all we might say of any one species:

"This insect occurs only in such and such an area, hence persons outside of this area are free from danger by it except by its possible migration or artificial spread." Without such definite and comprehensive data we must wait for each outbreak to show us, after the fact, just where each species is capable of damage. This same kind of definite information as to the distribution of all other groups of animals could be drawn upon in the same way. This group merely serves as a type to illustrate the point. Every man engaged in scientific work knows how dangerous is the policy of off-handed and unguarded declaration, but when one has his opinions backed by ample evidence secured by painstaking study of the facts, even his guess is of value.

(2) In the second group of insects, including the true bugs, a very considerable body of data has been accummulated, though

up to the present, only a portion has been published. A very consederable portion of the group is under study by Prof. Z. P. Metcalf, and other portions are well represented in the collections of Mr. C. S. Brimley, and the State Department of Agriculture.

(3) The third group, including the Dragon flies (also known as Mosquito hawks), May-flies, Stone-flies and related forms, is of relatively little economic importance, though many of them are of extreme biological interest. Mr. Nathan Banks, of the National Museum at Washington, found enough of interest in the North Carolina material submitted to him, so that he published a list of the state species known to him. In the introduction to his paper he says:

"North Carolina has a large and interesting Neuropterid fauna, and of particular interest is the Panorpodes, a genus elsewhere known only from Oregon and Japan." Mr. Banks has since done considerable collecting in vicinity of Black Mountain.

Of the sub-groups here represented our Dragon-flies (also appropriately known as "Mosquito Hawks") are perhaps best known. As these insects are water-breeders the species are more abundant in the east. Our approximately 100 species are recorded from nearly 50 localities, and certainly include the majority of species, yet the real Dragon-fly fauna of only one locality (Raleigh) it at all thoroughly known (67 species), Southern Pines and Havelock have a record of 32 to 39 species each, Lumberton shows 20 on record, while all the other localities show only a few each.

(4) The Moths and Butterflies comprise the most popular of all the groups of insects, on account of both the beauty and harmlessness of the adults. The Moths especially are of economic importance as the caterpillars of many are very destructive. The larger Moths occurring at Raleigh have been collected by Mr. Brimley and some have been published, but there are a host of smaller, hard-to-identify species which have been by no means thoroughly worked up. The day-flying Butterflies are better known though some additions are yet to be made in the "skipper" group of Butterflies.

Of Butterflies our list records about 115 species, and the records are from numerous localities over the state. Raleigh and Tryon lead with from 80 to 89 species. Cranberry and Southern Pines show 58 to 65 species. Localities showing from 20 to 32 species are: Beaufort, Lumberton, Goldsboro, Blowing Rock, Hendersonville and Andrews. These localities are sufficiently scattered and include a sufficiency of species to give us a reasonably satisfactory knowledge of the distribution (both geographical and seasonal) of most of the species. With the Butterflies our knowledge is if anything more nearly complete than for any other group of insects, though it is a relatively small group of relatively conspicuous insects, hence the data does not involve as laborious work as with some of the other groups.

Recorded from whole state	38 species.
Mountains only	12 species.
Westward but not confined to mountains	13 species.
Coast mainly	2 species.
Eastward but not in mountains	14 species.
Local and Scattering	28 species.

Here, as in the group containing the grasshoppers, we find that a very considerable portion of our species show a more or less definitely marked area over which they may occur.

(5) The True Flies comprise another very extensive group, many of which are small and delicate, hence their study presents special difficulties. But they are of much economic importance, especially in the light of recent discoveries of the part which the blood-sucking and house-inhabiting species play in the spread of human diseases. From the standpoint of Medical Entomology this is the most important group of all, so far as present knowledge goes. The group is quite well divided into a large number of families, a few of which have been studied to some extent, the Horse-fly family perhaps the most thoroughly of all. Of this family 41 species are on record for Raleigh, and about 28 each for Southern Pines and Havelock, with lesser numbers from a host of other localities.

The Mosquito fauna of the state is not yet well known, though there are indications that the present activities in health work will sooner or later give us some substantial knowledge of our forms and their distribution. Out of a fauna probably

numbering 35 species we only have positive record of a little over half that number. But as showing what striking facts even a little study of a state fauna may reveal, I may say that when Mr. Brimley began to collect the mosquitoes of Raleigh he soon found that the genuine yellow fever mosquito is one of our very commonest late summer varieties, in fact at times outnumbers any other. How widely is it distributed over the state? That we do not know, but it is just such information that a comprehensive biological survey of the state might furnish. Wherever that species of mosquito occurs, yellow fever might become epidemic if a victim of the disease should come into the locality, where it does not occur the disease could not become epidemic, according to present knowledge. Nor is the distribution of our malaria-carrying mosquitoes by any means fully known. Hence the need of more study on this group, as with the others also.

The large and beneficial family known as Syrphus-flies is being studied by Mr. C. L. Metcalf, and already our state list will compare favorably with that published for any other state.

(6) The Beetles comprise several thousand North Carolina species, only partially known as yet. Southern Pines and Raleigh have more species recorded than any other localities. The good showing of Southern Pines is due to the activities of Rev. A. H. Manee, who has collected upward of 900 species of beetles in that one locality. Many of the Southern Pines records in other groups are based on material collected by him. Working alone except for the help of specialists far from his locality, without access to large libraries or collections, Mr. Manee has nevertheless contributed a large number of interesting records.

I have said that this group has many species. As proof of this I may say that our card-catalogue now has credited to Southern Pines 845 species of beetles, to Raleigh 697 species, to vicinity of Waynesville 284 species, while very material contributions have come from Cape Hatteras, Beaufort, Chapel Hill, Greensboro, Hendersonville, Asheville, Lake Toxaway, Round Knob, Highlands, and Blowing Rock, and lesser numbers from other localities too numerous to mention. Much material in the group has never yet been identified nor recorded.

Considerable unrecorded collections have been made by Mr. Fiske at Tryon and by Mr. Beutenmuller among the Black Mountains. So it can be truly said that while our records may look formidable to the layman they in reality represent only a fair start on the list of beetles for the state.

(7) In the group comprising the Ants, Bees and Wasps very little thorough work has been done, and still less has been published. A paper on the "Ants of North Carolina" by Dr. W. M. Wheeler has been published, based largely on material collected by Mr. Beutenmuller in the Black Mountains. This group as a whole is beneficial and only a small proportion of the species are even potentially threatening to agriculture, and as many of them can sting, the collecting of them is attended by a certain degree of difficulty. Hence it happens that up to the present no resident collector of the state has become especially interested in the group, and many hundreds of our native forms are yet unrecorded.

Aside from the records from specified localities, our records show many species of insects which are credited merely to "North Carolina," with no indication of the locality where, or season when, they were collected. Such records are for the most part relics of the earlier days when collectors had not yet realized the value of locality and season records. But we now fully realize that to say that a specimen came from "North Carolina" means very little, for a considerable number of our eastern insects show affinities with the fauna of Florida, while many from the mountains suggest the fauna of Canada or the White Mountains of New England.

It would not be fair to leave this consideration of our insect fauna without naming some of those whose labors have added most to our knowledge. Of persons from outside the state who have collected here may be mentioned Prof. Morse of Wellesley College, Mr. C. W. Johnson of Boston, Mrs. Slosson of Staten Island, Mr. Beutenmuller of New York, Messrs. Laurent, Rehn and Hebard of Philadelphia, and Messrs. Hubbard, Schwarz, Banks and Fiske of Washington. Of outsiders who have identified a material portion of our difficult species may be mentioned Messrs. Schwarz, Heideman, Banks, Dyar, Coquillett,

Caudell, Crawford and Barber of Washington, and Professors Osborn and Hine of Ohio State University. Helpful lists of North Carolina material in their collections have been received from Cornell University, and from Messrs. Englehardt, of Brooklyn, Nason of Illinois, and Fenyes of California. Of persons now or in the past resident in the state and from whose work valuable help has come are: Mr. H. K. Morrison, formerly resident at Morganton; Prof. G. F. Atkinson of Cornell, formerly at our State University; Rev. A. H. Manee at Southern Pines, Mr. C. S. Brimley of Raleigh, and several men who have been associated with the speaker in the State Department of Agriculture, notably Messrs. Bentley, Woglum, Z. P. Metcalf and more recently his brother C. L. Metcalf. Doubtless there are others whom I have not mentioned but this is enough to show that the work upon our insect fauna has been by no means a one-man task. Merely a good start has been made upon this enormous, complex and yet highly important group.

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We now come to the vertebrated animals, forms with which we are more familiar, but in which each group contains, as compared with the insects, only a small number of species. First of these is the fishes.

IV. THE FISHES

While North Carolina is well supplied with streams and these streams are inhabited by a representative variety of native fishes, yet the vast majority of species which can be claimed as belonging to the fauna of the state, are found in our coastal waters. Fresh-water forms have been collected in the past by Messrs. H. H. and C. S. Brimley, and by such world authorities as Jordan and Everman, but it was not until after the establishment of the Biological Laboratory at Beaufort, that comprehensive data began to accumulate in regard to our marine forms, and it remained for Dr. Hugh M. Smith, U. S. Commissioner of Fish and Fisheries, to bring the data together in the "Fishes of North Carolina," published by our Geological and Economic Survey in 1907. It is indeed a splendid volume, and sets a high standard for works of this kind, and places our

recorded fish fauna upon a plane where it will compare most favorably with any other state. Dr. Smith acknowledges help from many co-workers, among them the Messrs. Brimley, and Prof. Gudger and Dr. Wilson of our Academy of Science.

V. REPTILES AND BATRACHIANS

The species of this group furnish a most excellent basis for studies in geographical distribution as they do not migrate to any considerable extent. While the number of species is not great many of them are of secretative habits, and as the group as a whole bears a rather unfavorable reputation, few persons have undertaken the serious study of our native forms. In no other group of animals is there so much of popular misunderstanding, superstition, unfounded tradition and fear.

A few specialists from outside have taken an interest in our fauna in this group, but the bulk of our data, which is now considerable, has been both secured and preserved by our fellow-member and proficient herpetologist, Mr. C. S. Brimley. Our reptile fauna is richest in the east, the batrachians are more evenly distributed over the whole state with many species confined to the mountain springs and rills. The forms occurring at Raleigh and Havelock are reasonably well known, and of those at Wilmington, Kinston, Black Mountain, Blantyre (Transylvania Co.), Andrews (Cherokee) and Sunburst (Haywood), the study is well advanced, while lesser but material contributions to what is known come from a number of other well-distributed and significant localities, including Beaufort, Cape Hatteras, White Lake (Bladen), Southern Pines, Greensboro, Winston, Highlands, Blowing Rock, Roan Mountain and Burnsville.

Here again I may call attention to a gap in our knowledge of an important animal. The Coral Snake, which is a poisonous species, is generally reputed to range from about Charleston, S. C., to the southward. There is one recent, authoritative record of its occurrence at Southern Pines. Presumably it occurs sparingly in other parts of our south-eastern area, but exactly where it does occur, no one knows. The distribution of

our other poisonous snakes is only partially known in detail, though the general regions inhabited by them can be defined.

VI. BIRDS

Of all the native animals undoubtedly the Birds hold first place in popular favor and we have had more resident observers of birds than of any other group. A very large body of records has been compiled and is now in course of being published by the Geological Survey. The authors are the Messrs. Brimley and T. G. Pearson, formerly a resident of the state and member of our organization. The Volume will, we hope, be a fitting companion to the one on Fishes, already referred to. In this group, fairly complete data is at hand from four localities which well represent the chief sections of the state, they are: Beaufort, Raleigh, Chapel Hill and vicinity of Asheville. Tribute should here be paid to the pioneer work of Mr. C. W. Cairns (now deceased), of Weaverville. Working single-handed in his leisure hours, he made known a large part of the bird-life of the Asheville region, and made material contributions to what we know of other groups in that section.

But even in this relatively well-known group we find some curious and awkward gaps in our definitely recorded data. Thus Currituck County has a record of 37 species of water-fowl and shore birds, but the Sharp-shinned Hawk is the only land bird on positive record. Another case in point is found in the group of owls. The Barred Owl is probably our most common and widely distributed owl, but has found its way into our records of only four localities, while the Barn Owl, which is one of our least common owls is recorded from no less than thirteen distinct localities. As with many other things the explanation is easy when you know it. The Barred Owl is not especially conspicuous and creates no striking impression when seen, hence the hundreds that are doubtless killed every year excite no curiosity and only the bird student who is interested in placing every species on exact record, takes actual note of its presence. But the much scarcer Barn Owl, is of striking and ludicrous appearance, and so seldom seen that when one is captured the captor is apt to think that he has discovered a new species of bird, and

not infrequently gets his name in the local paper with a sufficiently accurate description of the bird, so that it can be positively recorded.

In this connection I may call your attention to two more interesting facts brought to light in the study of our bird fauna. Until about 1900 the Song Sparrow, which is a delightful singer and a favorite in regions where it nests, was known in this state only as a winter resident, leaving for the north at the approach of the nesting season. Neither Cairns, or other very competent observers ever recorded it as nesting in our mountains, though their observations were comprehensive and reliable. We have every reason to believe that this fine little bird did not stay in our state at all through the summer during that period of time. But about 1900 records of its occurrence in our mountains in summer began to creep in, and in 1908 Mr .C. S. Brimley and the speaker confirmed its presence during the nesting season in a number of our mountain localities and data has since accumulated to show that it is now one of our commonest nesting birds throughout our mountain region. Another interesting fact is that in 1908 observations showed that the pestiferous English-sparrow was not established in the town of Highlands (Macon County) and the most common bird of the street and door-yards was the native Carolina Junco or "snow bird".

It is an interesting fact that Raleigh and Asheville (vicinity) which are the two best studied localities, have exactly the same number of species (207) on record. In water and shore birds, Raleigh has the greater number by three, while with the land birds the case is reversed. Only three other localities, namely Beaufort, Havelock and Chapel Hill, have over 100 species on record. Reasonably creditable records are available from Pea Island, Durham, Highlands, and Andrews, and material contributions have come from quite a number of other localities.

Merely to observe and record the birds seen, is not especially difficult, for even an amateur can soon become fairly proficient in recognizing the species, but to obtain exact data on migrations, especially the fall migrations to the southward, and on the regions where each species nests, is far more difficult. Hence

although much data has been secured from many persons in many localities, much of the more detailed work still remains unfinished.

VII. MAMMALS

This is the only group in which any considerable reliance can be placed on common report, and even here it must be accepted with discrimination. If one can secure the positive statement from a reputable resident, that deer or bear occur in that locality the record can be accepted because the species are distinctive and cannot possibly be confused with other kinds. But when it comes to recording the different species of smaller mammals, like mice and bats, only careful collecting will reveal the truth. In addition to what is known of the marine mammals of our coast, the land forms occurring at Raleigh and Asheville are quite well known, 36 at Raleigh and 27 at Asheville. From 15 to 20 species are known from Bertie County in the east and Roan Mountain in the west. From 7 to 12 species are on record for eight other localities.

* * * * *

Such is the condition of our recorded knowledge of the fauna of the state. I have not attempted to discuss the flora, though a study of it would be included in any attempt at comprehensive Biological Survey work, but I doubt not that in the flora as with the fauna, much is already known, with many equally important gaps in the record. Upon this point our botanical members may, if they wish, enlighten us at other times. But we know they have not been negligent in the study of our varied forms of plant life, and we may hope that their ambitions will not be satisfied until they thresh out the questions of occurrence and distribution upon a reasonably comprehensive scale.

The collection of such data as I have been attempting to discuss is what we may properly term Biological Survey work. I have attempted to show that it means more than the mere listing and description of species. Of equal or even greater importance is the mapping out of the regions where the species occur, and in the case of those whose activities are seasonal, of defining the seasons when their important activities are evident. The need of

this is obvious for all forms which are of immediate economic importance. It is also apparent for all that host of forms which have potential powers for good or evil, while with the many forms which for the present seem to be of no direct importance we need the same data not only to strengthen and complete the chain of information, but because we never can tell when some unsuspected relationship between them and our welfare may be discovered.

The accumulation of data of this kind and its publication, could but supplement and strengthen the work of those who are chiefly interested in the study of that other branch of biology,—morphology. And it would furnish a safer ground-work for such directly economic studies as the life-histories of destructive insects, the spread of weeds and of fungous diseases of plants. Closely allied to it would be studies on the interplay of biological forces; influence of parasites on host of birds and insects, of birds in spread of weeds, of insects on spread of plant and animal diseases, etc.

In state Biological Survey work, Illinois seems to be in the lead with a state Laboratory of Natural History established by law and supported by legislative appropriation since 1885.

Certainly for the present I do not believe that North Carolina could be expected to appropriate of its public funds for work of this kind, but I cherish the hope that those of our institutions and individuals who are interested in biological work, may find some way to so correlate their efforts that more help may be given from one to another. Might we not hope by such an united effort to prepare and publish, as time goes on, volumes on the other groups of animals, as has already been done for the fishes? Can we not hope for similar work on the plants? The question of means for publication may appear serious, but the speaker is persuaded that when any worker or body of workers has secured and carefully assembled the data, that some means of publication and of illustration also, can be found. Our Geological Survey has made a splendid start in this, and surely some way can be found for its continuance.

During the past year, in Ohio, some twelve or more educational institutions have united their efforts to establish the

work of a State Biological Survey in which all may take part and share in the benefits of the data and material collected. This plan had its origin in the Ohio Academy of Science. From the introduction to the first Bulletin of the Ohio Biological Survey the following is quoted:

> "The object of the Survey will be to secure accurate and detailed information as to the occurrence, distribution and ecology of the animals and plants of Ohio, for the benefit of the people in general and particularly for those engaged in school instruction, and to collect, identify and distribute material that may be of service in educational work."
>
> "The co-operative board is planned to consist of a representative from each institution and organization agreeing to the plan of co-operation and contributing a membership fee of $25.00, such representative to be appointed by the executive officer in the institution or organization."

It seems to me that some similar method might be adopted by interested institutions in our state, making provision also for individuals who are not connected with institutions. Additional funds might be needed as the work progressed, but some correlation of effort and interest would seem to be the first essential step.

Notice that the Ohio plan involves the idea of making this work of benefit not only to the workers themselves, but also to "the people in general." This implies a popularization of the knowledge acquired by the Survey. In our own state I do not think the conditions were ever better nor the need more urgent for the popularization of all kinds of scientific knowledge than at present. Witness the extension work of our Agricultural College and State University, and the farm demonstration work conducted from Washington. North Carolina is still essentially a rural state. We have no large cities. Any able-bodied citizen can in a half hour walk from his residence into the woods and fields where Nature's innumerable forms of life surround him on every side. Man is himself an animal and derives his physical sustenance from Nature's substances, hence I am much inclined to accept the remark I once heard from the lips of a distinguished zoologist to the effect that "every person is by nature a potential naturalist." Mr. Brimley tells me that in England a much larger proportion of the birds, flowers, and

insects are called by familiar names by country children, than is the case here. In America we have thus far tended less toward the popular study of scientific subjects and this is to be regretted. We need all over the state a popular awakening to the beauty, variety and importance of the forms of life around us. We need students who shall know our animals and who can instill an interest in them into the lay mind. We need other students to do the same for our flora. Both furnish delightful fields for recreation among persons who may be ordinarily engaged in commercial pursuits.

What has thus far been accomplished in making known our plant and animal life has been done chiefly out of pure fondness for the subject itself, the material and data being gathered quite incidental to the performance of other duties. The accumulation of the data which I have here attempted to summarize, has been going on for many years. And if perchance it should seem to anyone that it is extensive, we may humble ourselves by remembering that what little is now known is but a meagre suggestion of what yet remains to be learned.

RALEIGH, N. C.

THE OCCURRENCE AND UTILIZATION OF CERTAIN MINERAL RESOURCES OF THE SOUTHERN STATES.

(*Continued from June Number*)

By Joseph Hyde Pratt.

PLATINUM.

A very systematic search has been made throughout a number of the Southern States for platinum and grains of platinum have been reported to have been found in the sands from placer gold washings in Rutherford and Burke counties, North Carolina [1]. Mr. W. E. Hidden made a very thorough search for platinum at these reported localities but failed to discover any, and the present writer has examined very carefully many of the reported localities without having discovered any native platinum. This metal has also been reported from a number of localities in Georgia but they are no more authentic than those of North Carolina. Mr. Hidden said in regard to his exploration for platinum in the South: "I will state that at the many places where I operated I did not succeed in finding any traces of its existence." The southern states of Virginia, North Carolina, Georgia and Kentucky have always attracted considerable interest from those who have been searching for platinum inasmuch as in these states are found large deposits of peridotite and serpentine, associated with which is more or less chromite. In many parts of the world where platinum has been found in alluvial deposits, it has been associated with chromite and serpentine. It has also been found directly associated with chromite, and as chromite originated in the serpentine, or rather in the primary rock, peridotite, it would seem to indicate that the original source of the platinum was also the peridotite or an allied igneous rock. Although no platinum has yet been found associated with these rocks in the South, it is not unreasonable to expect that some day it will be found [2].

[1] U. S. Geol. Survey, Bull. 74, 1891, p. 14.
[2] Pratt and Lewis: N. C. Geol. Survey, vol. 1, 1905, p. 373.

Platinum in the form of arsenide ($PtAs_2$), known as a mineral sperrylite, has been found very sparingly at the ruby mines in Cowee Valley, Macon County, North Carolina.[3]

PRECIOUS STONES.

The production of precious stones has never been very large in the Southern States but these states have produced some of the most unique and exquisite gems that have been found in the United States. Two of these gems, hiddenite [4] and rhodolite [5] were first identified in North Carolina and thus far have not been found in any other State. The first of these was discovered in 1881, at Hiddenite, Alexander County, and ranks near the diamond in price on account of its great rarity. The rhodolite was discovered in 1895 on Masons Branch of Cowee Creek, and has been quite extensively mined. North Carolina, Kentucky and Arkansas have been favorite fields of exploration for the diamond as all three of these states contain a rock that is very similar to the rock in which the diamonds are found in South Africa. Diamonds have been fonud in Virginia, North Carolina, South Carolina, and Georgia in placer mining, but none have thus far been found in place. Very recently, diamonds have been found in Arkansas and the locality seems to give promise of developing into a genuine deposit of these gems. The Southern States of Virginia, North Carolina, and Georgia have produced some of the finest amethysts that are on the market, and North Carolina has produced some of the most beautiful blue and golden beryls that have been found in the United States. Two other gems that have attracted a great deal of attention in the Southern States are the ruby and sapphire. As has been stated above, corundum occurs quite abundantly in the Southern States and in a great many of the mines blue and red corundum were discovered. This caused considerable interest in these deposits as a probable source of the ruby and sapphire, and although in many of these mines a few sapphires and an occa-

[3] Am. Jour. Sci. Vol. V, pp. 294-296.
[4] Am. Jour. Sci. *Ibid.*
[5] Am. Jour. Sci. *Ibid.*

sional ruby were found, none of them produced a great amount of material. A ruby deposit, however, was discovered in 1893, in Cowee Valley, Macon County, North Carolina, that has produced some remarkably fine rubies equal in color and lustre to any of the Burma stones. Although these ruby deposits have been developed for a great many years, only a very small amount of material obtained has thus far found its way on the market.

COMMERCIAL MINERALS ASSOCIATED WITH PEGMATITE.[6]

Many of the minerals that were assigned to the author for discussion are associated with pegmatite. The mining of some of these has not proved profitable until some of the associated minerals could be produced and marketed. From some of the pegmatitic dikes in the Southern States several minerals are now being mined. Mica stands out prominently as the principal mineral obtained from these dikes, with kaolin a close second. The potash feldspars, which occur quite abundantly in some localities, have only recently been mined on account of their former distance from the railroad.

These pegmatites are not all of the same origin, some being true dikes of igneous origin and others having an aqueo-igneous origin. I shall not try to take up here any discussion regarding the origin of the pegmatites.

The three principal minerals of the pegmatitic dikes are quartz, feldspar, and muscovite mica, and these probably constitute about 95 to 99 per cent. of the dike. Besides these, there are a large number of minerals that have been found in these dikes, some occurring sparingly and others abundantly. There is given below a list of those minerals that are known to have been found in the pegmatitic dikes of the Southern States, and those which have been obtained in sufficient quantity to be of value commercially are marked with an asterisk.

LIST OF MINERALS FOUND IN THE PEGMATITIC DIKES OF THE SOUTHERN STATES

Actinolite
Albite* (Feldspar)

[6] N. C. Geol. Survey. Economic Paper 3, 1900 p. U. S. Geol. Survey Min. Res.

Allanite
Almandite* (Garnet)
Andradite (Garnet)
Apatite
Auerlite*
Autunite

Beryl* (emerald, yellow, blue and aquamarine)
Biotite* (Mica)
Brookite

Cassiterite*
Chabazite
Columbite*
Corundum*
Cyanite

Enstatite
Epidote
Eucryptite

Feldspar { Albite*, Oligoclase*, Orthoclase*, Microline* }
Fergusonite
Fluorite

Gadolinite*
Garnet { Almandite, Andradite, Pyrope, Spessartite }
Graphite
Gummite* (Uranium mineral)

Hatchettolite
Hematite
Hiddenite (var. of Spodumene)
Hyalite (var. of Opal)

Ilmenite (Menaccanite)
Iolite

Kaolin*

Limonite

Magnetite
Menaccanite (Ilmenite)
Mica { Biotite*, Muscovite* }
Microline (Feldspar)
Microlite
Molybdenite
Monazite*
Muscovite* (Mica)

Nivenite

Oligoclase* (Feldspar)
Opal (var. Hyalite)
Orthoclase* (Feldspar)

Phosphuranytile (Uranium mineral)
Pyrite
Pyrope (Garnet)
Pyrophyllite
Pyrrhotite

Quartz* (Massive, crystallized and smoky)

Rogersite
Rutile

Samarskite*
Spessartite (Garnet)
Sphene (Titanite)
Spodumene* (var. Hiddenite)

Tantalite
Thulite (var. of Zoisite)
Titanite (Sphene)
Topaz
Tourmaline (Black)

Uraninite*
Uranium Minerals { Gummite, Phosphuranytile, Uraninite, Uranotil
Uranotil

Xenotime

Yttrialite

Zircon*
Zoisite (var. Thulite)

A number of the minerals in the above list are described below in considerable detail while others are but briefly mentioned.

KAOLIN, FELDSPAR AND QUARTZ.

One of the alteration products of the feldspar of the pegmatitic dikes is kaolin. Some of the finest kaolin produced in the United States is obtained from the decomposed pegmatites in North Carolina, South Carolina and Georgia. These kaolins usually burn to pure white and are used in the manufacture of some of the finest china ware, enameled brick, etc.

In some of the dikes the feldspar is not altered at all and such dikes in Virginia, North Carolina, and Georgia are being

investigated for potash feldspar for use in the manufacture of pottery. Formerly this feldspar was too far from transportation to be profitably mined, but now since the railroads have penetrated into these districts, these deposits are available; and several are now being worked in North Carolina. These feldspars contain from 12 to 14 per cent. of potash.

Masses of quartz which are very pure are found in many of the pegmatitic dikes. It has two possible values: one for use in the manufacture of glass and the other in the manufacture of pottery. At the present time no quartz is being produced from these pegmatitic dikes for commercial purposes, but its prospective value is being investigated.

With these three raw products that are used in the manufacture of pottery—occurring abundantly in the Southern States—it is only a question of a little time when pottery manufacturing plants will be established somewhere in the South, and we will stop shipping all our raw products north and buying them back again in various forms of clay manufactured products, thus paying double freight rates. In the vicinity of many of the pegmatitic dikes are water powers which would be available for grinding the quartz or feldspar in preparation for use in pottery works.

RARE EARTH MINERALS.

Several of the rare earth minerals have been found associated with the pegmatites in the Southern States in commercial quantity. A commercial demand having arisen for certain chemical elements or compounds, mineralogical investigations were begun to determine a probable source of these elements, and in many instances the minerals containing them have been discovered in the South. Many of these elements have been required for use in the manufacture of certain lighting apparatus, as thoria in the manufacture of the mantles for the incandescent lamps; zirconia and yttria in the manufacture of the glower for the Nernst lamp; tantalum for use in the electric bulb; uranium (only experimentally) in the electric bulb; and tungsten in the manufacture of the tungsten electric bulb. With the exception of tungsten, minerals contain-

ing all the other elements have been found in commercial quantity in the Southern States. Monazite, a source of thoria, and zircon, a source of zirconia, are described in considerable detail beyond.

Uranium Minerals:—At several of the pegmatitic dikes in Mitchell and Yancey counties, North Carolina, the uranium mineral, uraninite and gummite, one of its alteration products, have been found in some quantity The amount of these minerals found in the pegmatitic dikes does not warrant mining for them only, but as a by-product in mica mining they will add considerably to the profit of the mine. It is of interest to know that the uraninite obtained from the Flat Rock mine, near Spruce Pine, Mitchell County, has shown the highest radioactivity of any uranium mineral thus far found.

Samarskite:—This mineral is one of the more abundant minerals containing the rare earth oxides, and large quantities of it have been found at the Wiseman mica mine in Mitchell County, North Carolina It is essentially a niobate and tantalate of iron and calcium with the cerium and yttrium metals, together with uranium oxide The yttrium oxides vary from 6 to 15 per cent., and the cerium oxides from about 2 to 6 per cent. The color of samarskite is velvet black, and its lustre varies from vitreous to resinous and splendent. It is commonly found massive or in flattened embedded grains, but occasionally in fairly well-developed prismatic rhombohedral crystals. Its usual occurrence is in pegmatitic dikes, and at the Wiseman mica mine, it has been found in masses over 20 pounds in weight. At other mica mines in North Carolina it has been found more sparingly.

Tantalum Minerals:—Columbite and tantalite, the two minerals that contain tantalum, are found to some extent in the pegmatites of the Southern States. Of these two the columbite is by far the commoner and occurs in greater abundance It has been found in some quantity near Amelia Court House, Amelia County, Virginia; the Wiseman and Deake mines, Mitchell County, and the Ray Mine, Yancey County, North Carolina; tantalite has been found in Yancey County, North Carolina, and Coosa County, Alabama. Thus far, how-

ever, there has been no mining of either of these minerals for commercial purposes.

MICA.

The first mica mining in the South was very evidently done by the Indians as old underground workings have been encountered, in some of which Indian implements have been found. That the Indians were attracted by the transparency of mica, probably for ornamental purposes, is shown by the old workings on mica veins that exist in western North Carolina. In a number of old workings which have been discovered and re-opened, stone Indian relics have been found. An interesting discovery has recently been made in Ohio in some of the old Indian mounds, which have been opened, of beads which closely resemble pearls. The outer covering of these beads is minute scales of a partially altered mica. As no mica occurs in Ohio, it must have been brought from some of the eastern states and perhaps from the mines of this section. Just what use the North Carolina Indians made of the mica they obtained is unknown, but as it could be readily cut and made into all sorts of shapes and was transparent, it would naturally attract the Indian.

The mining of mica for commercial purposes was first commenced in 1867, in North Carolina, and the mica obtained was superior to any mica that had ever been put on the market, and immediately became the standard mica by which other micas were judged. Since that date mica mining has been carried on in Virginia, North Carolina, South Carolina and Alabama, but with considerable variation in the production of the mineral. About 1885 there began the importation of mica (duty free) from India and a little later from Canada. This at once began to affect the Southern production, which continued to decrease until the McKinley tariff bill became effective in 1892-93, which placed a duty on mica. As one of the principal uses of mica was in stoves that were used for heating houses, there was a large falling off in the demand for the mineral with the decrease in the use of stoves for this purpose following the introduction of other methods for heating houses.

Up to this time there was no use made of the scrap mica nor for the small sheets, and it was not until about 1890 that a demand arose for the small sheets and punched mica for electrical apparatus. This demand for the waste mica together with the duty caused a revival of the mica industry of the South. A use was also found for scrap mica, to be used in manufacture of axle grease, wall paper, etc., which added greatly to the income of mica mining and greatly increased the production of the Southern mines. There has always been a strong competition between the Southern and the imported mica. The Southern mica was always able to easily compete with the foreign when there was a large demand for it for stoves, but with the smaller demand for this purpose and the much larger demand for use in electrical purposes, for which the foreign mica gives equal satisfaction with the Southern mica the competition has been greater, and often to the disadvantage of the Southern mica.

OCCURRENCE.

The muscovite represents the most common mica and is very widely distributed, being a component of many of the crystalline and sedimentary rocks. In many of these it occurs in but small scales or crystals which have no commercial value. When, however, it occurs in blocks or masses which can be split into sheets an inch or more in diameter, it has a commercial value which increases with the size of the cut sheets, and these vary from 1 by 1 to 8 by 10 inches. These commercial deposits of mica are found for the most part in pegmatitic dikes or veins, which occur as intrusives in granite and in hornblende and mica gneisses and schists, and have been mined in Virginia, North Carolina, South Carolina, Georgia and Alabama. These dikes or veins vary in thickness from a few inches to several hundred feet and are often very irregular, having arms or apophyses branching off from them and extending out into the country rock in many directions. Sometimes these dikes are parallel to the bedding or schistosity of the gneiss or schist, and then again they break across it at varying angles. Both of these phenomena are often observed in the same dike. The

principal mineral constituents of these dikes are quartz, feldspar, and muscovite mica, which occur in varying proportions. In examining these dikes it will be found that sometimes the quartz and feldspar are nearly equally distributed throughout a certain part of the vein, while in other parts sometimes one and again the other will predominate. Feldspar has been observed that has crystallized out in enormous masses of more than a ton in weight, and in one instance, at the Irby mine, near Spruce Pine, Mitchell County, North Carolina, a well-developed crystal of feldspar was observed that measured 3 by 11 1-2 feet. Occasionally feldspar, quartz, and mica have separated out in rather small masses, giving the vein the appearance of containing an equal quantity of each. In such cases the three minerals are so intimately associated with each other that the mica is of little or no commercial value and the feldspar is also of no commercial value. Judging from observations made at a great many mica mines the pegmatitic dikes that yield the best commercial mica are those in which the three minerals have had a tendency to crystallize out in large masses. Thus, where feldspar and quartz are in small crystals or fragments, the mica is also apt to be small. Those dikes that are two feet or less in width very seldom contain mica having any commercial value beyond what could be obtained for it as scrap mica, and hence little or no attention should be paid to such dikes as a source of mica. Not all of the wide dikes carry mica of the right quality or in sufficient quantity to afford profitable mining, for in some the mica has been observed to occur in such small crystals and blocks that no sheets could be obtained over an inch or two in diameter.

The muscovite mica occurs in these dikes usually in rough crystals (called blocks or books), which are sometimes distributed nearly evenly throughout the dike and at other times nearer the contact of the dike with the country rock. These blocks of mica are occasionally nearly perfect in their crystalline form, which is monoclinic, but imitating rhombic or hexagonal symmetry. The commercial blocks of mica usually vary in thickness from 6 to 18 inches and from 3 to 15 inches in diameter, although some blocks have been found as much as

4 feet in diameter and from 2 1-2 to 3 feet in thickness. All of the large blocks of mica are not of sufficient quality to cut into sheets as large as would be expected from the size of the crystal, on account of much of the mica having been converted into what is called "ruled mica", the mica being divided into narrow strips whose edges are parallel to the intersection of the prism and base edges of the crystal, or into "A" mica, in which the sheets are cut or striated parallel to two adjacent edges.

PERCENTAGE OF MICA IN THE DIKES.

There is considerable variation to be noted in the percentage of mica that occurs in these dikes and in different parts of the same dike. It is usually found, however, that in any considerable distance in the same dike the mica will average for that distance approximately the same per cent. It is seldom that the mica in a dike will average over 10 per cent. of the contents of the dike for any considerable distance, and it will sometimes average as low as 1 per cent. Portions of certain dikes have been observed that had the appearance of containing a very large percentage of mica on account of a number of blocks of mica being clustered together in bunches almost touching one another, while in other portions of the same dike there would be almost a complete absence of mica for a distance of from 5 to 20 feet; but even in such a dike the general average of the mica to the other minerals corresponded to about 10 per cent. The general limits of the percentage of mica in various dikes is probably, therefore, from 1 to 10 per cent.

Of the mica that is obtained in these dikes, there is probably an average of not over 10 to 15 per cent. that can be cut into sheet mica, the rest being waste or scrap mica. Selected masses or blocks of mica, however, have been mined that have averaged from 30 to 40 per cent. and occasionally as high as 75 per cent. of sheet or plate mica. On the other hand, there will be certain portions of the dike in which none of the mica mined can be cut into sheets or plates, and is all of value only as scrap mica. These variations have been observed where

they have taken place within the space of a few feet. As far as can be ascertained from observations in the field and from the results of mining, the North Carolina mines will average the highest percentage of cut mica of any in the United States.

There are a number of reasons for this large percentage of waste mica—the irregularity of the blocks of mica and of the individual sheets; the ruled mica and the "A" mica, which reduce the sizes of sheets that can be cut or prevent entirely any sheets being cut from the block; the mica may be specked or stained, or may contain a great deal of magnetite in thin crystallized films between the foliae of the mica; and many blocks of mica may be destroyed by having garnet, tourmaline, or quartz crystallized out between the foliae. It will be observed from what has been said that in mining mica there must necessarily be a very large amount of waste rock or gangue removed, and, as in nearly all mica mining it is necessary to operate by blasting, it makes the cost of production of the crude mica somewhat expensive. Hence, if any of the other minerals that must be removed in mining can be utilized commercially, they will make valuable by-products and will help to pay the cost of mining the mica.

One of these minerals, feldspar, has already become of commercial importance and is now being produced in North Carolina. Pure quartz, free from oxides that would discolor any glass made from it, occurs associated with the mica in many of the deposits, and investigations are now being made to determine the commercial value of this quartz as a source of raw material for the manufacture of glass.

The production of mica from the Southern States in recent years has been principally from North Carolina with much smaller amounts from Alabama and Virginia. North Carolina produces two-thirds of the value of the total production of mica in the United States.

Other minerals occurring in these pegmatitic dikes which are being mined for mica that will make valuable by-products are kaolin, uranium minerals, samarskite, beryl, and other gem minerals.

MONAZITE

The discovery that thoria would make a much better incandescent mantle for lighting purposes than zirconia made it necessary to discover commercial deposits of some mineral containing a considerable percentage of this compound. The mineral that offered the best chance of furnishing this salt was monazite, which had been discovered in 1879 by W. S. Hidden [7]. Prospecting was carried on quite vigorously for this mineral, chiefly in North Carolina, with the result that it was found in considerable quantity. Since this first discovery the North Carolina areas containing this mineral in quantity have been very largely extended and it has also been found in South Carolina.

The first commercial shipment of monazite was in 1887, and the production was continued each year until 1910, but since then no production.

Monazite also furnishes ceria (CeO), another salt that is used in very small amount in the manufacture of incandescent mantles; and is also used by pharmacists.

OCCURRENCE

Monazite is found very widely distributed as an accessory constituent in varying proportions of many granites and their derived gneisses. Thus it has been found in the porphyritic, granulitic, and schistose gneisses of the Maritime Mountains of Brazil, extending for a distance of 300 miles through the provinces of Bahia, Minas-Geraes, Rio de Janeiro, and Sao Paulo; and in the granitic mica-gneisses and hornblende-gneisses of the South Mountain region of North Carolina, covering an area of some 3,000 square miles in McDowell, Burke, Caldwell, Rutherford, Cleveland, Polk, Catawba, Iredell, Alexander, Lincoln, and Gaston counties, and extending into Spartanburg, Lawrence, Greenville, Pickens, Anderson, Oconee, South Carolina. Although occurring in but small quantity it has been identified in the granites or gneisses of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York,

[7] Am. Jour. Sci., (3) vol. 21, 1881, p. 159, and (3) vol. 32, 1886, p. 207.

North Carolina, South Carolina, and Georgia. In North Carolina there are a number of mica-schists that carry monazite, as that near the Deake mica mine, Mitchell County, and at Milholland's mill, Alexander County.

The rocks of this monazite area are for the most part gneisses, schists and granites. These vary considerably and are grouped under the following heads:

1. Carolina gneiss.[8]
2. Roan gneiss.[8]
3. Granites.
4. Pegmatites.

The Carolina gneiss is the oldest formation and is of Archean age. Its structure varies considerably, the more common types being mica, garnet, cyanite and graphite gneisses and schists. Associated with this Carolina to such an extent that it is a rather characteristic feature is pegmatite and, as will be seen later, this pegmatite is common throughout the portions of the area that carry monazite in commercial quantity.

The Roan gneiss, which is the next oldest formation in the monazite region, consists almost entirely of hornblende gneiss and schist. The granites of the area are gneissoid, porphyritic and massive in structure and while of uncertain age, they are probably Archean.

The pegmatite occurs in two distinct phases; one in which it forms distinct masses or bodies with the typical composition and texture of pegmatite, while the other phase is a pegmatized gneiss which represents the addition of the pegmatite minerals to the gneisses which has caused a partial recrystallization of portions of the gneiss. The structure of the pegmatite is irregular, occuring in some places in sheets or lenses interbedded and folded with the enclosing gneisses and schists, while in other places it occurs in dikes, veins or lenses either conformable with the enclosing rocks through part of its extent and cutting across them in other parts, or in irregular masses

[8] U. S. Geological Survey, Asheville Folio, No. 116, 1904; pp. 2 and 3.

having no definite orientation with respect to the accompanying formations. All the rocks in this area are more or less weathered and decomposed and a clue to the nature of the rock formations themselves is often obtained by a study of the character of the gravels in the bottom lands and streams draining a particular region. Thus, a very light colored gravel with quartz debris indicates a granite or a very highly pegmatized country rock. Garnet and hematite, with fragments of mica or cyanite gneiss, indicate Carolina gneiss. When quantities of black sands containing magnetite, ilmenite, hornblende, etc., are found in the stream gravels, it is an indication of the Roan gneiss. Monazite occurs for the most part in the pegmatized gneiss and schist bodies which are phases of the Carolina gneiss. The texture developed during the pegmatization is generally porphyritic and there may be a gradation from the porphyritic gneiss into more or less highly pegmatized gneiss and from this into regular pegmatite.

In those beds or portions of beds where there has been little pegmatization, there is but a small amount of monazite. It is also true that where pegmatization has been complete and but little of the original gneiss remains, there is but little monazite. The chief occurrences of the monazite are in those portions of the gneisses and schists which have been highly pegmatized and are rich in secondary quartz and contain numerous small masses of feldspar with some biotite, graphite and other accessory minerals. The monazite is nearly always well crystallized, although the crystals are extremely small. The percentage of the monazite in the rock is very small and will not average over .75 of one per cent. An attempt has been made to work the rock itself, but it was found impossible to do so at a profit on account of the low percentage of monazite.

The origin of the monazite in the pegmatized gneisses and schists was either by the bringing together of the elements necessary for its formation from the original rock during recrystallization, or by the introduction of these elements into the pegmatizing materials from external sources. This form of pegmatization is usually in close proximity to granite mas-

ses which gives evidence of its formation through magmatic agencies.

Associated with the Carolina and Roan gneisses of Madison County, North Carolina, about 4 1-2 miles southwest of Mars Hill, there is an unusual occurrence of monazite.

The principal country rocks of this area are Carolina and Roan gneiss and Cranberry granite.

In this particular vicinity the Carolina gneiss occurs as outliers from the main formation and is not interbanded with the Cranberry granite. Immediately to the east there is a large mass of Roan gneiss and this is also observed farther to the west. The Cranberry granite as it occurs in this vicinity is also in the form of outliers or apophyses from the main mass lying to the north and west. It is an igneous rock composed of quartz and orthoclase and plagioclase feldspar with biotite, muscovite, and, in places, hornblende as additional minerals. There are a number of accessory minerals as magnetite, ilmenite, garnet and epidote, found in this granite. This granite occasionally contains pegmatite areas and, on the Whiteoak Creek, a great deal of the gneiss and granite was pegmatized.

There are no extensive areas of rocks outcropping on this hillside. Occasionally small boulders of the partially decomposed granite were observed containing more or less epidote and ilmenite forming a sort of ledge running around a hill about a third of the way to the top. About 100 feet up the hillside a shaft has been sunk to a depth of 45 feet. The rocks were decomposed throughout this distance so that no blasting whatever was necessary. On account of the excessive decomposition of the rocks, it was difficult to determine what the rocks at this particular point were. They had the appearance, however, of being decomposed Cranberry granite. The section exposed by the shaft showed the rocks to be more or less pegmatized and to carry monazite the whole depth of the shaft. The monazite seemed to occur in the pegmatized band of the rock which, in the shaft as exposed, had a width of 2 1-2 to 4 feet and does not occur in any sense in a vein formation.

The monazite, which is of a clove brown color, was found in fragments or rough crystals varying from pieces the size of

a pea up to a large rough crystal that weighed almost exactly 60 pounds. No attempt was made at this time to determine the percentage of monazite that the rock would carry. One or two pans full of the monazite-bearing portion of the rock were dug out, which gave nearly a pound of monazite.

As stated above, the monazite is in the form of irregular fragments, rough crystals and cleavable masses. One of the best crystals observed was a part of a mass that weighed 6 1-2 pounds, which was made up of crystals in parallel position with some of the facies very perfectly developed. Another crystal, which was well terminated, weighed 12 ounces. It was 2 3-4 inches long in the direction of the *b* axis and 1 1-2 inches in the direction of the *a* axis and 2 1-4 inches long in the direction of the *c* axis. The prismatic facies of the *a* pinacoid were well developed as was also the unit pyramid *w*. The lower end of the crystal showed no terminations. The facies observed on these crystals were indentified by means of the contact goniometer and were as follows: *a* (100); *m* (011); *w* (101); *v* (111).

The basal plane *c* was not observed on any of the crystals but was observed as one of the parting or cleavage planes. Parting planes were also very prominently developed parallel to *m*.

The masses of monazite were very pure and one analysis made to determine the percentage of monazite in the masses showed it to contain 99.5 per cent. monazite. No chemical analyses have been made of the mineral beyond the determination of the thoria. This determination, which was made in the laboratory of the Welsbach Light Company, showed this monazite to contain 5.06 per cent. thoria, which is equal to the percentage of thoria in the best commercial monazite found in the South Mountain region.

The size of the crystals of monazite found in this deposit and the possibility of its developing into an occurrence of commercial value make the discovery a most interesting one.

With any new or increasing demand for Carolina monazite, this property will undoubtedly be further developed with a good prospect of its becoming a commercial source of thoria.

During the past three years the monazite industry of the

Southern States has practically ceased. In 1905 there was 1,350,000 pounds of monazite produced in the Carolinas, but in the past few years it has dropped to hardly 10,000 pounds.

ZIRCON

Zircon is commonly found sparingly in the crystalline rocks, especially gneisses, syenites, granites, in granular limestones, and in chloritic and other schists. Occasionally it is found associated with some of the iron ores. Occurrences of this mineral in quantity are not common, and there is but one locality in the United States where it has thus far been found in commercial quantity and that is in the vicinity of Zirconia, Henderson County, North Carolina. The zircons occur in a pegmatitic dike which is about 100 feet wide and has a strike of N. 50° E. It cuts up through the pre-Cambrian gneisses, and can be traced for a distance of about 1 1-2 miles. The upper portions of the pegmatitic dikes are badly decomposed and kaolinized to a depth of 40 feet or more. The zircons occurring in these dikes are of a grayish color and well crystallized, prismatic crystals terminated by the unit pyramid predominating. They occur for the most part in the feldspar, and where this is kaolinized it permits of an easy separation of the zircon crystals by hydraulic processes. As the feldspar becomes more solid and unaltered, the separation of the zircon is more difficult. In crushing the feldspar, however, the zircons readily free themselves from the gangue.

There are two deposits of these zircon crystals that have been worked; one near the southwestern end of the dike, which is known as the Freeman mine, and the other near the northeast end, which is known as the Jones mine. Owing to the slight demand for this mineral, there has been but little systematic mining carried on. Men and children are paid a certain price per pound for the zircon crystals, some of which they wash out of the soil, others out of the kaolinized gangue, and still others they break out by hand from the harder feldspar. The resultant product contains practically 100 per cent. of zircon.

The discovery of this commercial deposit, which was later developed as the Jones and Freeman mines, located near Zir-

conia, a station on the Southern Railroad, was largely due to the efforts of Mr. W. E. Hidden. Zircon was first discovered here in 1869 but no special importance was attached to it; and the first shipment was in 1888. Although the shipments of the zircon from this locality were never very large, yet they supplied the necessary material for use in the manufacture of the mantles for incandescent lights. Experiments regarding the most suitable material for the manufacture of these mantles were continued in the laboratories of the different companies, and in a few years it was discovered that thoria made a better mantle than zirconia, and therefore the demand for zircon began to decrease, until finally its production entirely ceased.

A new use, however, arose for zirconia—to be used in the manufacture of the glower of the Nernst electric lamp, and in 1902, mining for zircon on a small scale was again commenced at the Jones mine and has continued to the present time. In 1911 the Freeman mine, adjoining the Jones mine, also became a producer.

Associated with the zircon in these mines is auerlite [9], a mineral that contains approximately 70 per cent. of thorium oxide. It has been considered a hydrous silico-phosphate of thorium.

A special search will be made for auerlite while mining for zircon, and several kilograms have already been obtained.

Near New Sterling, Iredell County, a great many brownish, pyramidal crystals of zircon have been found in the soil, some of which were 1 to 3 inches in diameter. One crystal weighed about 6 ounces. The exact occurrence of these crystals has not as yet been definitely determined, but thus far there has been observed no indication of a commercial quantity.

There are small quantities of zircon found in all the monazite sands, which could probably be saved as a by-product. These crystals are very minute, and are transparent.

Gadolinite [10]:—There is also used in the manufacture of the glower for the Nernst lamp, yttria, which is found in some

[9] Am. Jour. Sci., III, vol. XXXVI, 1888, p. 46.
[10] U. S. Geol. Survey, Mineral Resources, pt. II, 1911, p. 1195.

quantity in the mineral gadolinite. This is another rare mineral, but the commercial demand for it was met by its discovery in quantity near Llano, Llano County, Texas.

TIN [11]

Tin ore in the form of cassiterite has been found in Virginia, North Carolina, South Carolina and Texas.

What may be called the Carolina tin belt extends from Gaffney, Cherokee County, South Carolina, in a general northeasterly direction across this county; the southeastern corner of Cleveland County, North Carolina, and across Gaston and Lincoln counties, North Carolina. The tin deposits found in Rockbridge County, Virginia, may be a continuation of the Carolina tin belt across Catawba, Iredell, Yadkin and Surry counties, North Carolina. The general direction of the rocks carrying the tin ore is the same as that in Virginia, and the continuation of this direction from the Carolina deposits would approximately cross those places in Rockbridge County, Virginia, where tin ore has been found. The same rocks that are outcropping in Surry County, North Carolina, are also in this same line and have the same general direction. The principal locality in South Carolina where tin ore has been found is about one mile north of Gaffney on land which belonged to Captain S. S. Ross. For a distance of 13 miles from a point about a mile northeast of the Ross mine no tin minerals have as yet been found. The next place in the belt where tin is known to occur is a short distance northeast of Grover, North Carolina, a station on the Southern Railroad. From this point tin ore has been found almost continuously for over 14 miles to within a few miles of Lincolnton. No tin has thus far been found in North Carolina northeast of the Lincolnton locality, nor in Virginia until the Rockbridge County deposits are reached.

The section of North Carolina and South Carolina in which the tin belt occurs is close to the border of the large area of Archean gneisses which extend over a large portion of the west-

[11] N. C. Geological Survey Bull. 19, 1904 pp.

ern part of North Carolina and the northwestern portion of South Carolina. Bordering these gneisses on the east, there is a series of granites and other igneous rocks extending from Cherokee County, South Carolina, across Mecklenburg, Cabarrus, Rowan, Davidson, Guilford, Caswell and Person counties, North Carolina, which have a general north to northeast direction. At the extreme southern portion of North Carolina, and extending into South Carolina, there is between these granites and gneisses a band of metamorphic rocks consisting of slates, schists, limestones, quartzites, and conglomerates whose age is unknown. These occur quite extensively developed in Cherokee County, South Carolina, and in Gaston, Lincoln and Catawba counties, North Carolina, and extend for a very short distance into Iredell County, North Carolina. No more of these rocks are observed in this northeast direction until they again outcrop in the northeastern portion of Yadkin County, extending nearly across Stokes County and almost to the Virginia line. They are in every way identical with those found further South and represent the same geological formation. Penetrating up into these rocks in Gaston and Lincoln counties, North Carolina, there is a mass of granite which is from five to ten miles wide. The schists vary considerably in character, sometimes being very siliceous and having a gneissoid structure. The general strike of these metamorphic rocks is northeast; and it is in this belt of rocks in North Carolina that the tin ore is found. The general strike of the pegmatitic dikes and veins carrying the tin is approximately the same as that of the metamorphic rocks, N. 25° E., but near the South Carolina line there is a rather sharp bend to the westward, so that from there to Gaffney, South Carolina, the direction of the tin belt is about N. 55° E., and it leaves the schists to the east and passes through the Archean gneisses. The rocks in the vicinity of Gaffney, South Carolina, are almost entirely gneisses, similar to those found in North Carolina to the west of the metamorphic rocks and which have been referred to as the Archean. There are, then, rocks of two distinct geological periods in which the tin veins have been found: (1) Those associated with the Archean gneisses, which are found

in the vicinity of Gaffney, South Carolina; and (2) those associated with the schists, which are of a later period, and with which most of the North Carolina tin is found. The ore at the Jones mine, 7 miles northeast of King's Mountain, is in greisen veins that occur in a gneissic rock, which may be a portion of the Archean gneisses to the west.

As has been stated above, the main country rocks are for the most part crystalline schists and gneisses, the former being micaceous, chloritic and argillaceous, and the latter micaceous and hornblendic. The strike of the schistosity of these rocks is usually in a general northeast direction and they dip for the most part at very steep angles to the westward. The veins in the gneisses are dipping toward the east at very steep angles.

The King's Mountain region of North Carolina is geologically situated in a band of metamorphic rocks composed of slates, schists, limestones, quartzites and conglomerates whose age up to the present time has not been definitely determined. The width of this belt near King's Mountain is about 10 miles and extends in a direction about N. 10° to 20° E. Just east of Lincolnton, Lincoln County, it joins another band of similar rock, the two being separated east of King's Mountain by a mass of granite. To the west of these metamorphic rocks are the Archean gneisses, with which the tin veins of Gaffney, South Carolina, are associated. The strata of these metamorphic rocks are tilted at very high angles to nearly vertical, and in the resultant alteration and erosion to which they have been subjected, the quartzites have resisted these influences the most, so that they now form the top of the peaks and ridges such as King's, Crowders and Anderson mountains, which rise 500 to 1,000 feet above the average elevation. It is undoubtedly the mass of granite which is to the east that has tilted these metamorphic rocks and thrown them into their present position.

There are a number of amphibole dikes that have been observed cutting these metamorphic rocks, but they have made very little change in the position of the schists through which they penetrated beyond a metamorphic action. These sedimentary rocks were tilted into their present position before the intrusion of these dikes, which are following partly the lamina-

tion of the schists and their general trend; but in a few instances are cutting across the schist. In two or three instances where these dikes are cutting across the schists, there are approximately parallel to them veins of tin ore. Pegmatitic dikes are also common throughout this belt of metamorphic rocks in North Carolina and in the gneisses further to the west in South Carolina. They could be followed almost continuously from three miles above Grover, North Carolina, to the Jones mine, 7 miles northeast of King's Mountain. In one place, a short distance below King's Mountain, North Carolina, the pegmatitic dike was all of 200 feet wide. They follow in many cases the planes of lamination of the schist which represent lines of least resistance. Where the pegmatitic dikes are cutting across the schists, they may be following old fractures that were produced at the time of the intrusion of the amphibole dikes.

About one-half mile below King's Mountain the pegmatitic rocks begin to outcrop very boldly and continue in this way nearly to Grover, North Carolina, a distance of 7 miles. This mass of pegmatite varies a good deal in width in this distance, from twenty-five to six hundred feet. Just in the northern edges of the town of King's Mountain there is another strong outcrop of the pegmatite, but from this point there is but little seen of the pegmatite northeast until Ramseur's mill is reached. Here the pegmatite has a width of about 200 feet.

A cross-section of the tin belt in the vicinity of King's Mountain would show the following sequence: hornblende-gneiss on the western boundary, followed on the east by schists which are in many places very badly decomposed; then a narrow bed of limestone, which is more or less siliceous; then quartzite; another bed of limestone; quartzite; schist; to the granite on the extreme eastern portion of the belt, having a total width of about 10 miles.

Perhaps the most extensive development work has been carried on near Lincolnton, Lincoln County, by the Piedmont Tin Mining Company. The property of this company, begins about 2 miles southwest of Lincolnton and extends in a general southwest direction for 2 miles, to the Little Catawba River, about midway between Long Shoal and South Side, two stations on

the Carolina and Northwestern Railroad. Tin-bearing pegmatite has been exposed at a number of places throughout this area, and has shown the existence of two or more approximately parallel pegmatitic dikes, which are also following the laminations of the schists and gneisses. There were other pegmatitic dikes also observed that were cutting the dikes referred to above and the lamination of the country rock. The company has acquired by purchase and lease control of a property about 2 miles long and 1 mile wide, which has been prospected more or less over its entire area.

The country rock of this section consists of hornblende and mica gneisses and schists that are intersected by the pegmatitic dikes, which sometimes are cutting across the strike of the schists and then again following it and at other times have sent off apophyses which have forced their way between the laminations of the schist and gneiss. Occasionally, a mass of the pegmatite is encountered that has all the appearance of a boss. These dikes are very variable in width from a few feet up to 30 or more. They have the usual mineralogical character of ordinary pegmatitic dikes, except that for the most part they are tin-bearing. The position of the tin in these dikes was carefully noted, and in nearly all cases it was observed that the main portion of the dike carried little or no cassiterite (tin oxide), but that this mineral was confined to restricted portions of the dike, which, in nearly all cases, was near the contact, of the pegmatitic dike and country rock. In these areas there was usually but little feldspar, and the dike was made up largely of quartz and mica. Occasionally, where the pegmatitic dike was narrow, tin oxide was found scattered sparingly throughout the whole mass.

The work done by this company has made this section the most favorable one for studying the occurences of these pegmatitic dikes and of the tin mineral which they contain. Beginning at the southwest end of the property, on a hill, just above the Little Catawba River, the company has sunk shafts and pits and made open cuts at various intervals from this point for a distance of 2 miles in a northeast direction to what is known as the Main Shaft mine, where the greater amount of

underground work has been done. Wherever any pegmatitic dikes have been encountered in this prospecting, they have contained more or less tin oxide, but in very varying percentages. The work has also shown that the pegmatitic dikes are extremely variable in width, both on the strike and dip. There are two points, one known as the Henry shaft and the other the Main shaft, where considerable underground work has been done.

It is the author's idea regarding the origin of the tin ore found in the Carolina belt, that it is due principally to the direct separation or recrystallization of the cassiterite from the molten pegmatite magma, with perhaps a little also due to a fumarole action, resulting from the escaping vapors during the crystallization of the molten magma of pegmatite intruded into the schists and gneisses in the form of dikes, which in turn had been subjected to the same reactions as the main mass of pegmatite.

None of the Southern tin deposits have thus far proved to be profitable producers of tin ore, although several tons of tin concentrates have been shipped from the Ross mine in South Carolina and from the mines in the vicinity of King's Mountain, and Lincolnton, North Carolina. The Lincolnton deposits referred to above have been developed to the greatest extent and have offered the greatest probability of developing a commercial source of tin. A large proportion of the pegmatitic dike which carries the tin has been decomposed and the feldspar been changed to kaolin. There is a possibility of this property becoming a producer of kaolin with the tin ore as a by-product.

Virginia:—The occurrence of tin in Virginia was described by Mr. Arthur Winslow in 1885, and later by Mr. Titus Ulke in 1893. This tin area extends along the eastern edge of Rockbridge County in the line of the Blue Ridge Mountains from a few miles north of the James River Gap to about the north line of the county. Cassiterite has been found at a number of places in this area, but the greatest amount of ore was found along the upper waters of Irish Creek in the northeastern corner of the county. There is one property that has been developed to some extent, and this is known as the Cash mine.

The greisen veins in which the tin occurs traverse the granite in all directions and are dipping at very steep angles. The width of these veins is usually from 8 to 12 inches, though some were observed that were several feet in thickness. The cassiterite is occasionally concentrated into seams from 1 to 2 inches wide and is associated with pyrite and arsenopyrite, the rest of the gangue of the veins being composed of quartz and mica. The principal work was done here about twenty years ago, and a concentrating mill was erected on the property and about 290 tons of rock were tested. It is reported that about 2,400 pounds of tin concentrates were shipped to Boston, but that they only averaged about 43 per cent. of metallic tin, due to the concentrates being contaminated with arsenopyrite and ilmenite. There was not sufficient work done on the property to definitely determine whether or not there existed a commercial deposit of cassiterite.

Texas:—Cassiterite has been found in Texas on the east flank of the Franklin Mountains, the southern extension of the Organ or San Andreas Range, about 10 miles north of El Paso. These deposits were discovered in 1899 and had been prospected to a depth of about 50 feet. The ore occurs in well-defined veins, which have a strike approximately east and west, which is nearly at right angles to the direction of the range and are dipping toward the north at very steep angles. There have been three veins discovered here, which have been exposed by pits and open cuts for several hundred feet along the strike. The veins occur in the granite and are considered by Mr. W. H. Weed to be the result of deep-seated agencies and that further exploration will develop well-defined tin veins.

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